

HEAT RADIATION OF THE STARS.

As every one knows, meteorology deals only with the heat received from the sun and its action on the earth and atmosphere. Those who believe in the influence of the moon and stars have never been able to show that these exert any appreciable influence on meteorological phenomena. The refinement to which scientific measurements have been pushed, and the exceeding minuteness of the heat effects, if any, are well shown in the following article by Prof. George E. Hale, quoted from *Popular Astronomy*.

In an important paper published in 1890,¹ Prof. C. V. Boys describes his unsuccessful attempts to detect heat radiations from the stars by means of an exceedingly delicate radiometer used in conjunction with a 16-inch reflecting telescope. In spite of the fact that his apparatus was sensitive enough to show the heat equivalent to that of a candle 1.71 miles away, no effect whatever could be obtained from Venus, Jupiter, Saturn, Mars, Arcturus, Capella, Vega, or any of the numerous bright stars observed. After discussing the earlier papers of Huggins² and Stone,³ Professor Boys concludes that the heating effects of stars, obtained many years ago by these observers with comparatively insensitive apparatus, were spurious.

The work of Dr. E. F. Nichols, Professor of Physics in Dartmouth College, in perfecting the radiometer, and adapting it for the measurement of heat radiations, has placed astrophysicists in possession of an instrument which for certain purposes is superior to the radiometer, bolometer, or most improved form of thermopile. In view of the remarkable sensitiveness of the radiometer and its suitability for stellar work, Professor Nichols was invited to make an attempt to detect stellar heat radiations with its aid at the Yerkes Observatory, Williams Bay, Wisconsin. The investigation was accordingly undertaken in July, 1898.

The experiments were made in the heliostat room of the Yerkes Observatory, where the radiometer, stably mounted upon a heavy pier, could be shielded from air currents and other sources of disturbance. The great steadiness of the reflected image of the scale, making it possible to record deflections to tenths of a millimeter, was doubtless due to this arrangement.

The radiometer, constructed by Professor Nichols especially for these experiments, essentially consists of a suspension system formed of two mica discs, each 2mm. in diameter, blackened on one face, and supported by a light cross-arm on either side of a thin glass staff, hung by an exceedingly fine quartz fibre in a partial vacuum. Both vanes were exposed to the radiation of the sky, at the focus of a silvered glass mirror of 24 inches aperture and 8 feet focus, made by Mr. G. W. Ritchie, optician of the Yerkes Observatory. Rays from the star were reflected into the concave mirror by means of a siderostat⁴ having a large plane mirror of silvered glass. After reflection at the concave mirror and also at the surface of a small flat one fixed at an angle of 45° with the optical axis, the rays entered the radiometer through a fluorite window.

With this apparatus a deflection of 0.1 mm. would be given by a candle 15 miles away, assuming total reflection at the silvered surfaces and neglecting atmospheric absorption. When the moon's image is made to fall on one of the vanes, the scale is instantly thrown out of the field of view. Professor Nichols' radiometer is about five times as sensitive as Boys' radiometer, and the area of his telescope mirror is 2.4 times that of the mirror used by Boys. In Professor Nichols' apparatus there is, however, one additional reflection.

Seven determinations of the heat radiation of Arcturus, made on August 4, 5, 7, 8, 9, 11, and 13, gave a mean deflection of 0.60 mm. Each evening's determination is the result of from 21 to 47 deflections, and the probable error of the corresponding means ranges from 0.08 mm. to 0.17 mm. Vega was also observed on seven nights, and gave a mean deflection of 0.27 mm. The ratio of the heat radiation of Arcturus to that of Vega, determined on five nights, is 2.1, 2.0, 3.0, 2.3, 1.0;⁵ mean, 2.1. These results are not corrected for atmospheric absorption.

In all cases the observer was ignorant of the probable direction of the deflection, and other precautions were taken to avoid bias. The results appear to be trustworthy, and the probable errors are not greater than might be expected in such observations. In view of the smallness of the deflections and the uncertainty which arises from the rapid fluctuations in the atmosphere, Professor Nichols does not greatly rely upon the quantitative value of the results. They may fairly be considered to show, however, that we do not receive from Arcturus more heat than would reach us from a candle at a distance of five or six miles, no account being taken in the latter case of atmospheric absorption.

THE FIRST VOLUME OF THE MARYLAND WEATHER SERVICE.

The publication of the first volume of the Maryland Weather Service marks quite an interesting epoch in the history of the development of the State weather services of this country. In so far as independent State services are maintained, their directors must necessarily develop and apply their energies in those directions that will best tell for the interests of the States. In this respect, Maryland has been highly favored. Prof. Dr. Wm. B. Clark, who founded the State weather service, and secures its annual appropriations from the State Legislature, has also received such hearty co-operation from the Chief of the United States Weather Bureau that we have here practically two institutions working side by side in complete harmony, viz, the Maryland Section of the Climate and Crop Service of the United States Weather Bureau, of which Mr. F. J. Walz is Section Director, and on the other hand, the Maryland Weather Service of which Professor Clark is director.

The Maryland Section is maintained entirely by the United States Weather Bureau, and does all the expensive routine work that is performed by similar sections throughout the country. The Maryland Weather Service expends its energies in developing a greater interest in meteorology, lecturing and teaching and stimulating the production of special memoirs, which it proposes to publish in the magnificent style of which the present first volume is an illustration. Nothing like this, in the way of paper, presswork, illustrations, and typography, so far as we know, has ever before been published anywhere in the world in the interests of meteorology. Such a magnificent volume commands admiration from all who have any bibliographic taste, as well as from those who are interested in the scientific subject-matter.

The idea of devoting the energies of the local State service to memoirs rather than to daily, weekly, monthly, and annual bulletins and reports is a highly important step in the development of our science. For a century past, well established astronomical observatories had been famous for publishing great volumes of figures, showing the results of actual observations and stars, when, about 1840, Struve announced that the new observatory at Poulkova would publish memoirs as fast as they could be properly prepared, but would not, for the present, publish annual volumes of observations. In meteorology, as in astronomy, all important progress must be embodied in the memoirs that contain the results of the investigations of able physicists. As preliminary to these, observations and minor studies must be made and published. Every brilliant memoir that marks the upward pathway of science has been preceded by years of less brilliant work—the so-called "grind" of daily routine. After clearing away the errors of the past, it becomes possible to obtain new and more correct views, just as one cuts down the forest in order to let the sunshine in. We understand that the succeeding volumes of the series that Professor Clark has thus happily begun, will be devoted to monographs on meteorological and climatological matters intimately connected with the commercial, financial, and agricultural welfare of Maryland. This implies that he will secure a high grade of employees as investigators and statisticians, in order that the subject-matter may command as high a degree of admiration as does the typographical aspect of the volume. It is evident, therefore, that in future we must look to Maryland and its weather service as one of the most successful patrons of high class work in meteorology.

Among the many words of praise for this first volume we quote the following:

¹ Proceedings of the Royal Society, vol. 47, p. 480, 1890.

² Ibid., vol. 17, p. 309, 1869.

³ Ibid., vol. 18, p. 159, 1870.

⁴ Kindly loaned by the Allegheny Observatory.

⁵ Sky very hazy.